

FMT (FLIGHT SOFTWARE MEMORY TRACKER) FOR CASSINI MISSION OPERATIONS  
- A GROUND DATA ANALYSIS TOOL”

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ABSTRACT

The Flight Software Memory Tracker (FMT) is a ground data analysis “Tool”, developed for generic mission operations, that has been customized to the specific design of the Cassini spacecraft.

Tracking flight software (FSW) images on-board spacecraft is a vital activity in ground systems and mission operations. This is particularly true for one-of-a-kind spacecraft built for space and planetary exploration, upon which the FSW requires constant maintenance, patches, parameter changes, and occasionally even complete new memory loads. Complete and accurate knowledge of current and past FSW images is essential.

In the history of spacecraft operations at the Jet Propulsion Laboratory (JPL), ground mission operations analysts utilize various degrees of automation, integration of software tools and manual procedures to track FSW. While dynamic memory addresses can only be tracked by full-up hardware and software simulation, static memory addresses, constants, and certain quasi-static parameter addresses are always tracked. For address spaces of interest, an up-to-date FSW image, a FSW image at a specific time in history, and a trend of certain parameters over time, are often the basis for analysis, diagnosis and prognosis.

For Cassini mission operations, FMT is used routinely to track FSW code and parameter address spaces of interest for the AACS (Attitude and Articulation Control Subsystem) and the CDS (Command and Data System). Multiple ground FMT images are maintained. These images are living images which are updated per activity commanded or sequenced on-board the spacecraft.

FMT maintains a history of every FSW image copy on-board the spacecraft. AACS has twelve images, corresponding to the two redundant AACS\_A and AACS\_B RAM (Random Access Memory) images, eight SSR (Solid State Recorder, A and B, each with four memory\_load partitions) images, and two BAIL (EPROM backup storage) images. CDS has ten images, corresponding to the two redundant CDS\_A and CDS\_B RAM images and eight SSR images.

When on-board FSW images are updated, FMT images are updated accordingly. As living images, FMT maintains a history of every FSW image copy on-board the spacecraft. FMT images can be “evaluated” at any specific time of history, can be queried for history and statistics, and can be processed to produce human readable parameter values in engineering units instead of machine representation, etc. On-board FSW images are updated by uplink commands transmitted to the spacecraft. The same commands can be parsed and interpreted by FMT to produce update data groups which can be appended to FMT images. Memory readout of spacecraft address spaces (in addition to normal telemetry downlink) can also be used to update FMT images. Generic commands to update on-board FSW images and FMT images can also be generated by FMT

through an analysis of differences in specific FMT images subsequent to intended or unintended spacecraft reinitialization, or in order to revive specific images / parameters at specific instances of history.

Providing a capability to handle/archive/query large volumes of data and user friendliness for mission operations analysts presented a design challenge for FMT. This paper is limited to the operations aspects of this tool, software engineering and JAVA software design aspects of FMT are discussed in a separate paper.

FMT is implemented as a program set, comprised of multiple “utility” programs. Some of the utilities are programs that also call other FMT utilities. FMT users are best served by executing scripts, such as UNIX scripts, to achieve the higher-level objectives of FMT.

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